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The importance of feedback in the flipped classroom: motivation and academic performance in university students

La importancia del feedback en el aula invertida: motivación y rendimiento académico en universitarios

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ABSTRACT

The flipped classroom has generated great interest among teachers and members of the scientific community due to its encouraging results. However, this methodological approach has some fundamental characteristics, including teacher feedback. Few studies have analysed how teacher feedback affects variables of educational interest (e.g. motivation and academic performance), which is the focus of this research. A total of 255 university students participated over three academic years, divided into one group that received teacher feedback (n = 125) and another group that did not (n = 130). A quasi-experimental design with pretest and post-test measures was used, in which participants watched a total of 16 instructional videos and responded to a series of related questions, as well as completing a questionnaire on their motivational regulations, validated in the university context (PLOC-U). They also indicated the grade they expected to achieve at the end, another variable included in this research as a marker of academic performance. An interaction effect (time x treatment) was observed in intrinsic motivation (F[2]=4.250, p=.040; ηp2=.017) in favour of the group that received feedback, which was the only group to improve. Another interaction effect was observed in external regulation (F[2]=10.734, p=.001; ηp2=.041), which was higher in the group with feedback. Another significant finding is the interaction effect observed in the variable of amotivation (F[2]=6.035, p=.015; ηp2=.023), suggesting that the trend towards increased amotivation was mitigated only in the group that received feedback. Finally, the results show an improvement in the expected grade over the transcript grade for both groups (with and without feedback); however, the group that received feedback achieved a significantly higher grade (Z = 4.492; p < .001; ES = .28). In conclusion, the importance of feedback in the application of the Flipped Learning model is highlighted for positively impacting variables such as motivation and academic performance

Keywords: flipped classroom, teaching methods, active learning, educational technology, blended learning, instructional effectiveness

RESUMEN

El aula invertida ha despertado gran interés entre docentes y miembros de la comunidad científica por sus alentadores resultados. Sin embargo, este enfoque metodológico tiene unas características fundamentales, entre ellas el *feedback* del docente. Pocas investigaciones han analizado cómo afecta el *feedback* del docente sobre variables de interés educativo (e.g. motivación y rendimiento académico) cuyo aspecto constituye el objetivo de esta investigación. Participaron 255 estudiantes universitarios a lo largo de tres cursos académicos, divididos en un grupo que recibió *feedback* del docente (n = 125) y otro grupo que no recibió *feedback* (n = 130). *Un diseño cuasiexperimental con medidas pretest y post-test fue utilizado, en el que* los participantes visualizaron un total de 16 vídeos instruccionales y respondieron a una serie de cuestiones en relación con los mismos, y cumplimentaron un cuestionario sobre sus regulaciones motivacionales, validado al contexto universitario

(PLOC-U). Además, los participantes indicaron la nota que esperaban obtener al finalizar, otra variable incluida en esta investigación como marcador de rendimiento académico. Se observó un efecto de interacción (tiempo x tratamiento) en motivación intrínseca (F[2]=4.250, p=.040; ηp2=.017) a favor del grupo que recibió *feedback*, siendo el único que mejoró. Otro efecto de interacción se observó en la regulación externa (F[2]=10.734, p=.001; ηp2=.041), siendo mayor en el grupo con *feedback*. Otro hallazgo significativo es el efecto de interacción observado en la variable desmotivación (F[2]=6.035, p=.015; ηp2=.023), sugiriendo una tendencia al aumento en desmotivación amortiguada únicamente en el grupo que recibió *feedback*. Finalmente, los resultados muestran una mejora de la nota esperada sobre la nota del expediente de ambos grupos (sin vs. con *feedback*), sin embargo, el grupo que recibió *feedback* obtuvo significativamente mayor calificación (Z=4.492; p <.001; ES=.28). En conclusión, se destaca la importancia del *feedback* en la aplicación del modelo *Flipped Learning* para incidir positivamente en variables como la motivación y el rendimiento académico.

Palabras clave: aula inversa, métodos de enseñanza, aprendizaje activo, tecnología educacional, aprendizaje combinado, eficacia docente

INTRODUCTION

The COVID-19 pandemic marked a historic milestone in global health but also created a turning point in the global education system, exposing vulnerabilities and forcing an unprecedented adaptation. As a preventive measure, classes were suspended in schools, universities, and other educational institutions, affecting the regular academic and professional training of 90% of the student population worldwide (United Nations Educational, Scientific and Cultural Organization [UNESCO], 2020). Subsequently, in higher education, distance learning was initially used exclusively for certain courses, while blended learning began to be implemented in others, particularly for subjects with a strong practical component (Hassan Rakha & Abdo Khalifa, 2024).

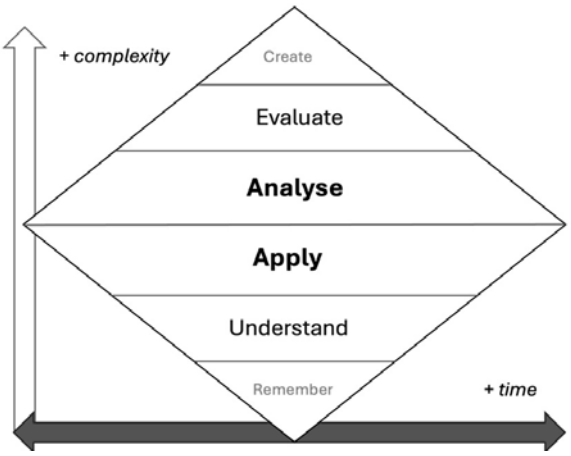
The flipped classroom model (FL) is a specialized form of blended learning in which students receive instructional materials (notes, web videos, recorded lectures, etc.) before attending in-person sessions (Thai et al., 2017). In 2018, Jon Bergmann and a group of experts updated the original definition coined in 2014 (Santiago & Bergmann, 2021, p. 24):

> *FL is a pedagogical model that enables educators to reach every student, in every classroom, every day. This approach reverses the traditional classroom model by introducing conceptual content before class, allowing teachers to use classroom time to guide each student through activities, strategies, and active practices related to the fundamental concepts previously covered.*

As observed in the updated definition, for its creators (Bergmann & Sams, 2012), FL is not merely about "watching videos" or completing some tasks before each class. Instead, to implement an effective FL approach, a series of additional characteristics must be met, distinguishing it from other similar models (self-directed learning, independent study, distance learning, etc.). On one hand, the FL approach reduces direct instruction in the group or collective space—not denying its importance but rather emphasizing the convenience of shifting it more significantly to the student's individual space. On the other hand, this transformation allows the classroom or group space to become an active and dynamic learning environment where teachers and students interact, replacing traditional lecture-based instruction with active and participatory learning. This group space can be transformed into an active and collaborative learning environment through a variety of methodologies that enhance student interaction and engagement. Among these methodologies are peer teaching, project-based learning, mastery learning, inquiry-based learning, role-playing, case studies, scenario-based learning, simulations, structured discussions, the initiation-response-feedback method, peer learning and review, cooperative learning, and gamification (Santiago & Bergmann, 2021). Each of these methodologies enables the adaptation of classroom activities to students' needs, fostering deep and active learning around the concepts already covered in the individual space. Aligned with this approach, an adaptation of Bloom's taxonomy (1956) to the FL model is presented in a diamond shape (Figure 1), representing classwork time. This model emphasizes dedicating more time to activities where the teacher (the student's most valuable resource) aids precisely when it is most needed: applying and analysing content.

Figure 1

Bloom's Taxonomy Adapted to the Flipped Learning Model (created based on Santiago & Bergmann, 2021, p. 28)



Consequently, a key advantage of the FL model is that it allows teachers to provide feedback to students after their individual work at home, granting greater prominence to teacher intervention within the framework of formative assessment. Hattie & Timperley (2007) state that feedback is one of the most powerful instructional interventions for enhancing learning. This feedback is understood as the response that teachers provide to guide and improve student learning within the group space, helping to bridge the gap between the student's current knowledge and the desired learning objectives. To achieve this, feedback plays an essential role in answering the three key questions proposed by Hattie & Timperley (2007): *Where am I in the learning process?* – allowing students to understand their current position in relation to the objectives; *What is expected of me?* – helping them clearly grasp the task requirements; and *How do I reach those goals?* – providing the necessary guidance on actions and strategies to close the gap between current and desired performance.

In this way, it not only enhances self-regulation and fosters deeper, more autonomous learning, but also strengthens intrinsic motivation and promotes positive attitudes toward learning (Wisniewski et al., 2020). According to the meta-analysis conducted by Wisniewski et al. (2020), an important distinction is made between different types of feedback that can be applied in the FL model, reinforcing the effectiveness of teacher intervention. Among these types are reinforcement or punishment feedback, which applies pleasant (or aversive) consequences to increase or decrease the frequency of a desired response; corrective feedback, which provides information about the task in terms of whether the response is correct or incorrect; and high-information feedback, which not only includes details about the task but also about self-regulation, such as monitoring student attention or motivation throughout the learning process. Additionally, Finn et al. (2018) demonstrated that feedback provided to students, when accompanied by examples, improves performance and conceptual understanding of the subject, reinforcing its central role in the FL model and its positive impact on learning.

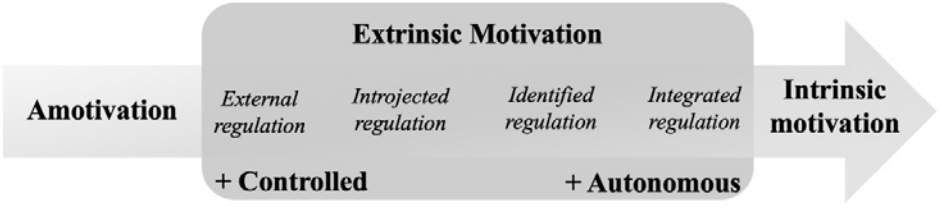
Recent reviews have analysed the effects of the FL model in both university settings (Bosch-Farré et al., 2024; Galindo-Domínguez & Bezanilla, 2019; Prieto et al., 2020) and non-university contexts (Gosálbez-Carpena et al., 2022). Although Spain has been identified as the country with the highest contribution of publications and interest in this model within the field of Physical Education (Østerlie et al., 2023), other reviews indicate a greater number of publications in the Asian and American continents, particularly in the fields of science and education (Bosch-Farré et al., 2024). This highlights the cutting-edge relevance of the topic and underscores the variables that have attracted researchers' interest

On the one hand, student motivation is the most studied variable (Gosálbez-Carpena et al., 2022; Østerlie et al., 2023). Although most included studies conclude that the FL model enhances motivation, few have examined motivation from the perspective of Self-Determination Theory (SDT, Ryan & Deci, 2019), which has already demonstrated extensive coherence and applicability. Specifically, one of its mini-theories, the Organismic Integration Theory, explains how different forms of motivational regulation influence various individual behaviours. This theory distinguishes three types of motivation: *intrinsic motivation*, which is based on engaging in an activity for the inherent satisfaction it provides; *extrinsic motivation*, which focuses on performing an activity to gain external recognition or to achieve something; and *amotivation*, which refers to the absence or loss of motivation toward the activity.

Considering that student motivation exists along a continuum (Figure 2), the Organismic Integration Theory describes different subtypes of *extrinsic motivation*, some more controlled and others more autonomous (Ryan & Deci, 2020). At the most controlled end, an individual may be motivated by external rewards or pressures, known as *external regulation* (ER). Next, within controlled motivations, is introjected regulation, where behaviours are guided by internal control to avoid anxiety, shame, or guilt associated with failure, with a strong focus on self-approval and the approval of others. On the autonomous side of *extrinsic motivation*, identified regulation and *integrated regulation* are found. The former refers to the conscious acceptance of the value of the activity. The latter, the most autonomous form of extrinsic motivation, implies that the individual not only recognizes and values the activity but also considers it coherent with their interests and core values. However, integrated regulation is difficult to assess through tests, as it tends to saturate in factor analyses of intrinsic motivation within university settings (Sanchez-De Miguel et al., 2023). More autonomous forms of *extrinsic motivation* are more enduring than controlled forms; individuals persist in the activity even in the absence of external rewards, guided by a sense of value and purpose in their actions (Ryan & Deci, 2020).

Figure 2

Self-determination continuum in the different types of motivation (adapted from Deci & Ryan, 2000)



Motivation is one of the most analysed factors in studies on FL (Østerlie et al., 2023). These studies have primarily focused on primary and secondary education levels rather than conducting a detailed analysis of motivation types under SDT in higher education contexts. In fact, recent studies, such as that of Gil-Botella et al. (2021), have demonstrated that the FL approach significantly increases intrinsic motivation and decreases amotivation in primary school students. Hinojo Lucena et al. (2019) reported similar results in both primary and secondary students, showing increased motivation when comparing the FL model with a control group. In secondary education, Martínez-Campillo (2017) observed that student motivation doubled when using FL, and Østerlie & Kjelaas (2019) found that this approach increased motivation toward participation in Physical Education (PE) classes. On the other hand, some studies (Campos-Gutiérrez et al., 2021; Gómez-García et al., 2019) did not find a significant increase in student motivation under the FL model compared to traditional methods. However, these results were attributed to factors such as the short duration of the FL intervention or abrupt methodological changes.

Despite the positive results regarding motivation in pre-university levels, the literature reveals a clear lack of scientific studies exploring these effects in university students from the specific perspective of SDT. There is a need for a thorough analysis of how different types of motivation are influenced by the FL approach, especially regarding the impact of teacher-generated feedback within university settings.

Therefore, the present study aims to address this research gap by providing empirical data on the outcomes related to changes in different types of motivation among university students after the implementation of an FL approach understood through the lens of SDT.

On the other hand, most studies (Chiang et al., 2019; Ferriz-Valero, Østerlie, García-Martínez, et al., 2022; Ferriz-Valero, Østerlie, Penichet-Tomas, et al., 2022; Marqués-Molías et al., 2019; Moreno-Guerrero et al., 2024; Soriano-Pascual et al., 2022) have observed significant differences in learning outcomes or academic performance after applying an FL model, demonstrating its effectiveness at all educational levels, especially in higher education (Bosch-Farré et al., 2024). Taking a deeper look at the relationship between the FL model and academic performance, a research gap still exists. Goh & Ong (2019) concluded that FL is more effective for students with low academic performance, whereas Wozny et al. (2018) found that it is more effective for students with above-average academic records.

Finally, although teacher intervention is a key aspect in these variables (Fenandez-Rio et al., 2023; Ferriz-Valero et al., 2024) as well as in the effective implementation of the FL model, no research has focused on how teacher feedback affects the variables that attract researchers' interest—student motivation and academic performance in higher education.

Objective and Hypotheses

Based on the above, the objective of this study was to quantitatively assess the effects of teacher-provided feedback (i.e., reinforcement, corrective, and high-information feedback) during the implementation of the FL model on motivation and academic performance in university students enrolled in a teaching degree.

Based on this objective and the robustness of SDT, the following research hypotheses were proposed:

Hypothesis 1 (H1). Students who followed the FL model with teacher feedback showed a significant increase in intrinsic motivation compared to the group that did not receive teacher feedback.

Hypothesis 2 (H2). Students who followed the FL model with teacher feedback showed a significant decrease in amotivation compared to the group that did not receive teacher feedback.

Hypothesis 3 (H3). Students who followed the FL model with teacher feedback showed a significant improvement in academic performance compared to the group that did not receive teacher feedback.

METHODOLOGY

Research Design

The research was conducted over three academic years (2021-22, 2022-23, and 2023-24) within official teaching programs at a Spanish public university. The study followed a quasi-experimental design with convenience sampling (i.e., access to the sample), including two treatment groups (experimental and control) as well as pre- and post-intervention measurements. The first experimental group implemented the FL model, requiring students to watch 16 pre-class videos related to the subject (learning in the individual space), allowing the collective space to be used for teacher-generated feedback (reinforcement, corrective, and high-information feedback). In contrast, the second control group followed the same video-watching routine at home but did not receive teacher feedback in the group setting. This control group, referred to as the "no-feedback" group, represents a variation of the FL model that does not fully meet its criteria but allows the research design to isolate the role of teacher feedback within the FL approach concerning motivation and academic performance. To test the proposed hypotheses, four classes were randomly assigned to the "no-feedback" group and another four to the "with-feedback" group, while ensuring that the same three instructors (n=3) taught both groups (all experienced in flipped learning). This methodological choice aimed to control for potential teacher-related effects, ensuring that identical content and

teaching styles were used in both treatment groups. The study design was based on previous research in similar studies (Thai et al., 2017, 2020). Finally, the study received ethical approval from the Ethics Committee of the University of Alicante (UA-2023-05-27_2).

Participants

A total of 400 university students initially participated in the study (M age = 20.47 years; SD = 2.63). The inclusion criteria for this research were: 1) Being enrolled for the first time in the core second-year course of the Primary Education Teaching degree at the University of Alicante (Spain). 2) Belonging to one of the groups taught by an expert in Flipped Learning. 3) Having digital devices and internet access at home. A total of 255 students were included in the final sample, of whom 154 were female (60.4%), after excluding 145 students for meeting one or more of the following exclusion criteria: a) Irregular class attendance, i.e., attending less than 80% of all sessions (n = 21). b) Failure to properly complete the questionnaires (n = 76). c) Failure to sign the informed consent form (n = 48).

Intervention Program

According to Hastie & Casey (2014), a rigorous intervention should include: a) A detailed description of the curricular elements of the intervention. b) A comprehensive validation of the intervention model. c) A precise description of the program's context. The following sections describe these elements in detail. The intervention was conducted within the second-year mandatory course Didactics of Physical Education, which is part of the Primary Education Teaching degree and accounts for six ECTS credits in the Spanish university system. The primary objective of the course is to provide future Primary Education teachers with basic knowledge of motor learning and sports education.

The course content is organized into 11 topics, of which only three were included in the intervention (see Table 1). Assessment, which is part of one of the dependent variables (academic transcript grade), was structured as follows: fieldwork assignments (20%), demonstration of mastery of acquired knowledge (25%), competence in designing a Physical Education learning scenario (25%), and a written exam (30%).

Table 1
Summary of Research Design (Curricular Elements)

	Content	Video Resource (min:sec)	Session No. (~115 min)
Topic 3 – Teaching Styles I	Conceptual Approach	6:01	1
	Traditional Styles	6:52	
	Participatory Styles (Reciprocal Teaching)	4:08	2
	Participatory Styles (Small Groups)	1:47	
	Participatory Styles (Microteaching)	2:52	
	Total	**21:40**	
Topic 4 – Teaching Styles II	Individualized Styles	7:18	3
	Socializing Styles	3:33	
	Cognitive Styles: Guided Discovery	5:09	4
	Cognitive Styles: Problem Solving	2:21	
	Creative Styles	3:33	5
	Conclusions	4:04	
	Total	**26:38**	
Topic 6 – Basic Physical Capacities	Physical Capacities in Primary Education	4:47	6
	Flexibility	6:40	
	Strength	8:06	
	Endurance	8:24	7
	Speed	4:24	8
	Total	**32:21**	**8 sessions (~16 hours)**

Note. min= minute; seg=second.

The intervention program was conducted by three instructors who were experts in the Flipped Learning approach (5–7 years of experience), with an average of nearly 10 years of university teaching experience (9.5 ± 2.52 years). A single instructor led the intervention within each group and remained in charge throughout the process, minimizing any potential bias resulting from multiple professionals intervening. To facilitate video viewing by students, the Edpuzzle platform (https://edpuzzle.com)

was used. A key advantage of this platform over others (e.g., YouTube) is that all students have free access to their personal accounts through a highly intuitive and user-friendly interface, allowing them to access and watch all videos without issues. Additionally, an essential aspect of implementing the FL approach, which this study aims to demonstrate, is that Edpuzzle allows students to answer embedded questions within the videos prepared for the course. This feature enables instructors to track who has watched the videos and under what conditions. The platform represents a highly valuable resource for research due to the data it provides, including the total time spent watching the video, the segments replayed, and whether students correctly answered the embedded questions. Moreover, it allows feedback (reinforcement, corrective, and high-information feedback) to be provided to students both in the individual space (via the digital platform) and in the group space (only for the "with-feedback" group).

As shown in Table 1, the intervention was conducted over eight sessions, each lasting 115 minutes, spanning approximately four weeks, with a total duration of around 16 hours. Both the "no-feedback" and "with-feedback" groups followed the same course content, used the same educational platform (Edpuzzle), and watched the same videos (16 videos in total), amounting to approximately 80 minutes of viewing time. These videos were recorded by a single instructor (the principal investigator) but were designed and supervised by the other instructors (Figure 3). Additionally, both treatment groups answered the same set of questions (45 questions, including open-ended, true/false, and multiple-choice formats) while watching each video (Appendix 1).

The session structure consisted of four main phases, specifically designed so that the only difference between the two groups was the presence or absence of teacher feedback:

Phase 1. Reinforcement and Corrective Feedback (only for the with-feedback group). The instructor focuses primarily on incorrect responses given by most students in the pre-class video or on the segments that were most frequently rewatched.

Phase 2. Peer Teaching. The instructor begins the group space with a peer-teaching dynamic in small groups (5–6 students), where each group reviews the key points covered in the video. After 10 minutes, the instructor randomly selects a group to share their conclusions with the entire class and then provides high-information feedback (only for the with-feedback group) on the group's interventions and the concepts discussed, delving into critical points or common misconceptions.

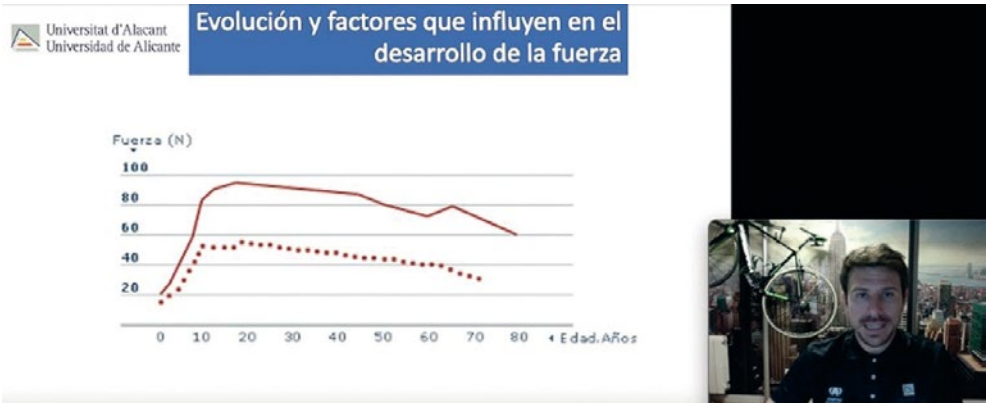
Phase 3. Case Study or Practical Scenario. The instructor presents a practical case that students must solve in groups. During this activity, the instructor provides high-information feedback (only for the with-feedback group), offering real-time corrections and reinforcement. The no-feedback group completes the activity

autonomously, receiving general guidance from the instructor but no direct feedback, encouraging reflection and self-assessment among group members.

Phase 4. Structured Discussion. To conclude, each group shares its potential solutions to the problem or case, moderated by the instructor. The goal of this discussion is to integrate knowledge and reflect on the different responses, achieving a deeper level of understanding. The instructor moderates the discussion, providing clarifications and/or specific recommendations.

Figure 3

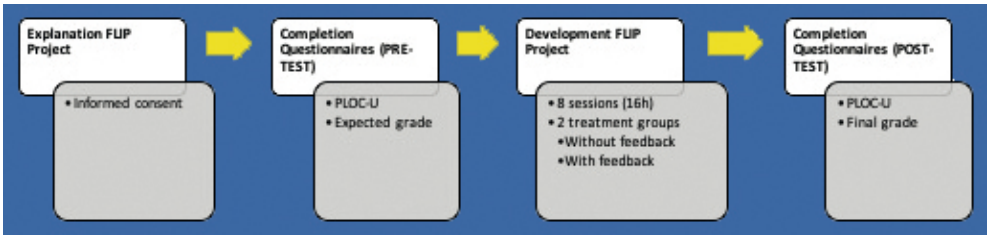
Screenshot from the video on Topic 6 (Basic Physical Capacities) detailing the fundamentals of strength development in childhood



Below, as a summary, a diagram of the research design implemented in this study is presented (Figure 4).

Figure 4

Research Design Outline



Instruments and Variables

Perceived Locus of Causality Scale (PLOC-U). This questionnaire aims to measure students' motivation regulation in the university context and is designed based on the principles outlined by Self-Determination Theory (SDT; Sanchez-De Miguel et al., 2023). It consists of 20 items (Table 2) grouped into five factors (four items per-factor), preceded by the phrase: "*I specifically attend the practical part of the course...*", measuring the entire motivational spectrum described by SDT, from intrinsic regulation to amotivation. Responses to the 20 items were provided on a 6-point Likert scale (1 = completely disagree to 6 = completely agree). This scale type was deliberately chosen to avoid central tendency bias. The Cronbach's alpha values ranged between .75 and .84 across all factors, indicating good internal consistency.

Table 2

Perceived Locus of Causality Scale in University Students (PLOC-U)

Factor	Items
Intrinsic Regulation	1. … because, in the end, what matters is what I learn, rather than the points I get from the continuous assessment of practical sessions.
	6. … because I find satisfaction in improving my technical and physical activity skills.
	11. … because I enjoy acquiring additional knowledge that complements the theoretical part of the subject.
	16. … because practical sessions make the subject more engaging for me.
Identified Regulation	2. … because it helps me to better complement theoretical knowledge.
	7. … because I see that working well on the practical component of this subject is important for me.
	12. … because I want to acquire technical and practical resources.
	17. … because it is an important part of my training as a sports educator.
Introjected Regulation	3. … because if I do not attend, I feel bad about myself.
	8. … because it serves as a reference for passing the subject later.
	13. … because it gives me one more step towards passing the subject.
	18. … because I worry about not attending the practical sessions.

Factor	Items
External Regulation	4. … because the practical assessment system allows me to obtain up to 5 points towards the final grade of the subject.
	9. … because, more than learning, what matters most is obtaining points for the practical component.
	14. … because this is what I have to do within the academic context I am in.
	19. … because, otherwise, I would not achieve the minimum grade to pass.
Amotivation	5. … but I do not see the benefit of practical sessions.
	10. … but I do not understand why this subject needs to have practical sessions.
	15. … but I still do not see the advantages of these practical sessions.
	20. … but, to be honest, I do not know why I attend the practical sessions.

Note. The preceding phrase is: "In particular, I attend the practical component of the subject because…".

Student Academic Transcript Grade. This scalar variable measures the score obtained by the student in their academic transcript upon completion of the course, using a 0 to 10 scale.

Data Analysis

The statistical software SPSS version 28.0.0.0 (190) was used for all analyses. Descriptive statistics for each factor (mean and standard deviation) were calculated. The Kolmogorov-Smirnov normality test was performed, revealing non-normal distributions in all cases ($p < .05$). To analyse baseline differences between the two treatment groups, a Mann-Whitney U test was used. An intragroup comparison (Wilcoxon test) was then conducted to analyse pre-test vs. post-test differences. Finally, to test the hypotheses, a repeated-measures analysis of variance (2x2 ANOVA) was conducted to enhance the robustness of the analysis. The dependent variables were the five motivational regulations (intrinsic, identified, introjected, external, and amotivation). Time (pre- and post-intervention) was the within-subjects factor, while group (no-feedback vs. with-feedback) was the between-subjects factor. The Levene test was used to assess homoscedasticity, the Mauchly test to assess sphericity, and the Box test to assess equivalence of covariance matrices. All assumptions were met except for data normality and the Mauchly test, leading to the use of multivariate contrasts. Effect size was calculated using Microsoft Excel (Dominguez-Lara, 2018). For the Mann-Whitney U and Wilcoxon tests, effect sizes were classified as small (0.1–0.3), medium (0.3–0.5), and large

(>0.5) (Cohen, 2013). For ANOVA, effect size was determined using partial eta squared (ηp^2), with thresholds for small (.01–.059), medium (.06–.13), and large (≥.14) effects. A 95% confidence interval was calculated for the differences, and the significance level was set at $p < .05$.

RESULTS

Initial Differences Between Treatment Groups (Pre-Test)

The baseline characteristics of both groups are presented in Table 3, including the statistical differences obtained using the non-parametric Mann-Whitney U test. In the pre-test, the groups showed similar initial values, except for the variables intrinsic regulation ($Z = 3.692$; $p < .001$), introjected regulation ($Z = 2.618$; $p = .009$), and amotivation, where the with-feedback group had higher values in the first two variables and a lower value in amotivation.

Table 3

Mean ± Standard Deviation of Initial Differences Between Groups Using the Mann-Whitney U Test (Pre-Test)

Variable	Full Sample		*Without feedback* (n=130)		*With feedback* (n=125)		Z	*Sig.*	ES
	M	DT	M	DT	M	DT			
Motivational Regulations in Practice (Range 1-6)									
Intrinsic Regulation	5.06	0.74	5.04	0.72	5.09	0.76	0.649	.517	-
Identified Regulation	5.22	0.76	5.20	0.74	5.25	0.77	0.781	.435	-
Introjected Regulation	4.51	0.84	4.46	0.81	4.56	0.88	0.973	.331	-
External Regulation	3.92	1.01	3.94	0.97	3.89	1.05	-0.184	.854	-
Amotivation	1.73	0.98	1.84	1.14	1.61	0.82	-1.082	.279	-
Academic Perfomance									
Expected grade	7.11	0.76	7.11	0.70	7.11	0.81	-0.165	.869	-

Note. M = Mean; *SD* = Standard Deviation; *ES* = Effect Size.

Longitudinal Differences Within Each Treatment Group (Pre vs. Post-Test)

Table 4 presents the results obtained from the non-parametric Wilcoxon test. The results indicated that, on the one hand, the no-feedback treatment group showed a decrease in intrinsic regulation (Z = -2.813; p = .005) and identified regulation (Z = -2.022; p = .043), while an increase was observed in external regulation (Z = 3.893; p < .001) and amotivation (Z = 7.247; p < .001).

On the other hand, the with-feedback treatment group showed increases in introjected regulation (Z = 2.913; p = .004) and external regulation (Z = 6.160; p < .001) as well as academic performance relative to the expected grade (Z = 6.669; p < .001).

Table 4

Mean ± Standard Deviation of Intragroup Comparative Analysis Using the Wilcoxon Test

Variable	Pre-test		Post-test		Z	*Sig.*	ES
	M	DT	M	DT			
Without Feedback Treatment Group (n=130)							
Motivational Regulations in Practice (Range 1-6)							
Intrinsic Regulation	5.04	0.72	4.94	0.67	-2.813	.005	.25
Identified Regulation	5.20	0.74	5.13	0.72	-2.022	.043	.18
Introjected Regulation	4.46	0.81	4.54	0.70	1.855	.064	.16
External Regulation	3.94	0.97	4.20	0.80	3.893	<.001	.34
Amotivation	1.84	1.14	3.10	1.54	7.247	<.001	.64
Academic Performance							
Expected Grade vs. Final Grade	7.11	0.70	7.65	1.10	3.872	<.001	.34
With Feedback Treatment Group (n=125)							
Motivational Regulations in Practice (Range 1-6)							
Intrinsic Regulation	5.09	0.76	5.12	0.62	0.541	.589	-
Identified Regulation	5.25	0.77	5.22	0.65	-1.434	.151	-
Introjected Regulation	4.56	0.88	4.75	0.70	2.913	.004	.26
External Regulation	3.89	1.05	4.54	0.83	6.160	<.001	.55
Amotivation	1.61	0.82	1.85	1.21	1.282	.200	-
Academic Performance							
Expected Grade vs. Final Grade	7.11	0.81	8.32	1.01	6.669	<.001	.60

Note. M=Mean; *SD* = Standard Deviation; *ES* = Effect Size.

Final Differences Between Treatment Groups (Post-Test)

Table 5 presents the results obtained after applying the Mann-Whitney U test. After the intervention, the results indicate significant differences in intrinsic regulation (Z = 2.044; p = .041), introjected regulation (Z = 2.167; p = .030), external regulation (Z = 3.405; p < .001), and academic transcript grade (Z = 4.492; p < .001), with higher values in the with-feedback treatment group. Conversely, the variable amotivation (Z = -6.890; p < .001) was significantly higher in the no-feedback group.

Table 5

Mean ± Standard Deviation of Final Differences Between Groups Using the Mann-Whitney U Test (Post-Test)

Variable	Full Sample		*Without feedback* (n=130)		*With feedback* (n=125)		Z	*Sig.*	ES
	M	DT	M	DT	M	DT			
Motivational Regulations in Practice (Range 1-6)									
Intrinsic Regulation	5.03	0.65	4.94	0.67	5.12	0.62	2.044	.041	.13
Identified Regulation	5.18	0.69	5.13	0.72	5.22	0.65	0.823	.411	-
Introjected Regulation	4.65	0.70	4.54	0.70	4.75	0.70	2.167	.030	.14
External Regulation	4.37	0.82	4.20	0.80	4.54	0.83	3.405	<.001	.21
Amotivation	2.26	1.30	3.10	1.54	1.85	1.21	-6.890	<.001	.43
Academic Performance									
Expected Grade	7.72	0.95	7.65	1.10	8.32	1.01	4.492	<.001	.28

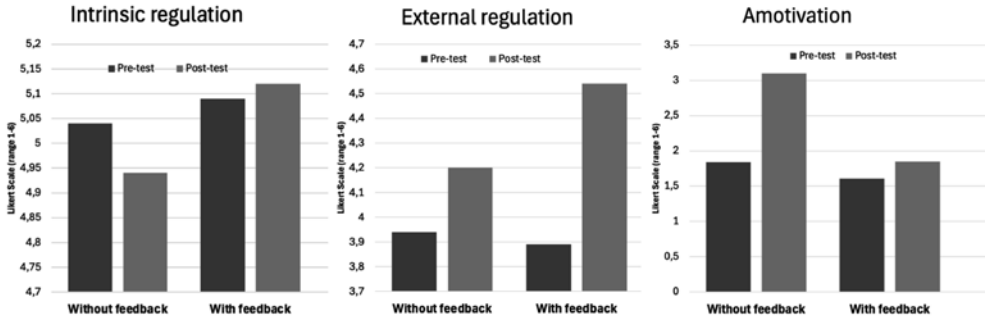
Note. M=Mean; *SD* = Standard Deviation; *ES* = Effect Size.

Hypothesis Testing

An interaction effect (Time x Treatment) was observed in the variables intrinsic regulation (F[2] = 4.250, p = .040; η_p^2 = .017), external regulation (F[2] = 10.734, p = .001; η_p^2 = .041), and amotivation (F[2] = 6.035, p = .015; η_p^2 = .023) (Figure 5). In other words, statistically significant longitudinal differences (pre vs. post-test, p < .05) were found in the impact of the treatment (with-feedback vs. no-feedback) during the implementation of Flipped Learning on these three study variables.

Figure 5

Representative bar chart of the effect of the Flipped Classroom intervention for both treatment groups (with vs. without feedback) on the variables Intrinsic Regulation, External Regulation, Amotivation, and Group Work



DISCUSSION

The FL model has emerged as an alternative approach to traditional university teaching, yielding positive results and, consequently, attracting the interest of the scientific community in recent years (Prieto et al., 2020). As presented in the state of the art, numerous studies have focused on analysing the effectiveness of the model concerning variables such as student motivation and academic performance (Bosch-Farré et al., 2024; Oudbier et al., 2022). However, other essential aspects of FL implementation have not been thoroughly explored, such as the role of teacher-generated feedback, a fundamental characteristic of the model (Santiago & Bergmann, 2021). It is important to highlight that, in this research, the "no-feedback" group does not represent FL in its strictest form but rather an experimental variation designed to isolate the effect of feedback within the FL context. The study of feedback importance remains underexplored in the scientific literature regarding FL implementation. Therefore, the objective of this study was to evaluate the effects of teacher-provided feedback during the implementation of the FL model on key educational variables, such as motivation and academic performance in university students.

The findings of this study confirm a significant interaction effect (time x treatment) on intrinsic motivation, with a small effect size ($\eta p^2 = .017$). It is important to highlight that this difference is observed despite the initially high scores of both treatment groups (above 5 out of 6). In other words, teacher-generated feedback plays a key role in enhancing students' intrinsic motivation, as a significant difference is observed in the feedback group compared to the no-feedback group. In fact, the no-feedback group shows a significant decrease in post-test scores compared to the

pre-test (Table 4), underscoring the impact of feedback on the most self-determined form of motivation in students. Therefore, Hypothesis 1 (H1) is accepted.

Although these results are novel and contribute to advancing the current theoretical framework on the FL model in higher education, numerous studies have already reported improvements in intrinsic motivation following the implementation of the FL model at other educational levels, such as primary education (Gil-Botella et al., 2021) and secondary education (Ferriz-Valero, Østerlie, García-Martínez, et al., 2022; Ferriz-Valero, Østerlie, Penichet-Tomas, et al., 2022). However, other studies (Campos-Gutiérrez et al., 2021; Gómez-García et al., 2019) did not find changes in intrinsic motivation or even reported a decline in motivation among female students in secondary education. This discrepancy in results may be attributed to significant differences in the implementation of this pedagogical model, as most studies lack sufficient detail to determine whether they follow recommended FL implementation guidelines (Bergmann & Sams, 2012).

The influence of the FL model on learning lies in its ability to motivate students to actively participate in their educational process, fostering greater personal engagement in their learning experience (Craft & Linask, 2020; Steen-Utheim & Foldnes, 2018). Thus, the benefits of the FL model largely depend on how it impacts student motivation and their willingness to engage both inside and outside the classroom (Gilboy et al., 2015).

Feedback plays a central role in the implementation of the FL model, not only due to its positive impact on intrinsic motivation and academic performance but also because of its ability to foster self-regulated learning skills (López-Belmonte et al., 2023). In this context, Zhang et al. (2023) analysed how different types of feedback significantly improved self-regulation skills and academic performance in pre-class activities among university students. Similarly, Esmaeili et al. (2020) compared the effects of feedback in English as a Foreign Language (EFL) class, finding that integrating the FL model with explicit feedback led to greater improvements in retention and grammar learning. This finding complements the evidence from the present study, demonstrating that the type of feedback can significantly modulate the benefits of FL.

Moreover, the decrease in intrinsic and identified regulation in the no-feedback group after the intervention suggests that the lack of feedback may weaken more autonomous forms of motivation (i.e., intrinsic motivation, integrated regulation, and identified regulation) in students, despite the absence of a significant interaction effect (Time x Treatment) for identified regulation. According to the definition of identified regulation, this type of motivation implies that the individual perceives tasks as aligned with their personal values (Ryan & Deci, 2019). For Vasconcellos et al. (2020), helping students develop this more internalized personal value is a

challenge not only for teachers but also for the educational system itself. Therefore, more specific research is needed to address questions related to this issue.

Conversely, an interaction effect was observed for external regulation, with a small effect size ($\eta p^2 = .041$). This indicates that students who followed the FL model with teacher feedback experienced a significant increase in more controlled extrinsic motivation compared to the no-feedback group. As demonstrated in previous research, external regulation is understood as a powerful form of motivation, although it is difficult to sustain over time, as it describes behaviours regulated by external contingencies (Ryan & Deci, 2017, 2020). Moreover, considering that university students are already adults and that higher education is not compulsory, they may develop an increased personal value toward the contingencies of the FL model. At first glance, this reasoning might reinforce the opposite idea, namely that students actively participate in class for intrinsic reasons (as stated in H1). However, it could also be interpreted as an indicator that participation in the innovative approach is related to a tangible reward, such as an increase in their expected course grade. Conversely, students might also perceive a negative response to questions as potentially leading to a decrease in their final grade. One could argue that the use of the Edpuzzle educational platform, which allows students to answer questions with correct and incorrect responses, could also explain this result. However, the no-feedback group did not receive qualitative information about their answers to these questions, making this argument purely speculative.

Another significant finding is the interaction effect (Time x Treatment) observed in the amotivation variable, with a small effect size ($\eta p^2 = .023$). This suggests that the tendency toward increased amotivation was mitigated only in the group that received feedback during the FL model implementation. Therefore, Hypothesis 2 (H2) is accepted. This result highlights the importance of support mechanisms and continuous monitoring in the training process of university students, such as teacher feedback, to sustain student interest and engagement within the FL framework. Although a slight decrease in amotivation was expected in the feedback group, the previously mentioned motivational regulations may be significantly influenced by various antecedents or social agents, as well as by the instructional videos used as FL model teaching resources. A total of 16 videos were used, all uniformly edited, without music or special effects, which appears to be closely related to student engagement and motivation (de la Mora Velasco et al., 2021). This factor could partially explain the observed result.

Other more conclusive studies have indeed observed a decrease in amotivation in primary education (Ferriz-Valero et al., 2017; Gil-Botella et al., 2021), secondary education (Ferriz-Valero, Østerlie, García-Martínez, et al., 2022; Ferriz-Valero, Østerlie, Penichet-Tomas, et al., 2022), and high school (Bachillerato) (Ferriz-Valero et al., 2017) in groups that implemented the FL model compared to traditional

teaching. A lack of research at the university level has been identified, making this result a valuable contribution to the theoretical framework of the FL model in higher education. However, further studies are needed to strengthen the robustness of these findings.

Finally, the results show an improvement in the expected grade compared to the final academic transcript grade in both groups (no-feedback vs. with-feedback), meaning that students achieved higher final grades than initially expected. However, the non-parametric Mann-Whitney U test revealed a significant difference in the academic transcript grade variable, indicating that the group receiving teacher feedback obtained a significantly higher final grade ($Z = 4.492$; $p < .001$; ES = .28). Therefore, Hypothesis 3 (H3) is accepted. This result is likely the most widely supported by the existing scientific literature, as evidenced by most studies analysed in various systematic reviews and meta-analyses within the university setting (Bosch-Farré et al., 2024; Galindo-Domínguez & Bezanilla, 2019; Prieto et al., 2020; Zheng et al., 2020). Furthermore, this study highlights that the teacher's role through feedback as part of formative assessment enhances the teaching and learning process, aligning with findings from other researchers (Finn et al., 2018). This confirms that the FL model is not merely about "watching videos" or providing materials before class, but rather involves active engagement and structured pedagogical support.

First, all participants belong to the same university and the same undergraduate degree program. Future studies with samples from different universities and degree programs would be necessary to generalize the results. Additionally, the study focused on a single course, making it necessary to conduct further research in other subjects (mandatory, elective, etc.) to determine whether the FL model is more effective in theoretical courses or, conversely, in more practical ones. Another important limitation concerns the presence of missing data during the intervention. A significant number of participants (n = 145) were excluded for various reasons, such as absenteeism, failure to complete pretest or post-test questionnaires, or lack of signed consent. This could have influenced the validity of the results, particularly regarding motivation, as absenteeism and non-compliance with measurement instruments may be linked to motivational factors. Since a detailed analysis of the distribution of these cases between groups was not conducted, this aspect should be considered a limitation when interpreting the study's results.

CONCLUSIONS

In the present study, the impact of the Flipped Learning (FL) model, with and without feedback, on various motivational regulations and academic performance

in university students was investigated. Various statistical tests were used to analyse the results obtained in the two treatment groups over three academic years.

The conclusions are as follows:

- The importance of teacher-provided feedback in the FL model implementation is highlighted, as it plays a fundamental role in increasing students' intrinsic motivation, showing a notable difference between the group that receives feedback and the group that does not.
- Teacher-generated feedback in the FL model plays a key role in mitigating the increase in student amotivation, showing a significant difference between the group that receives feedback and the group that does not.
- Teacher-provided feedback in the FL model allows students to achieve higher academic performance.

THEORETICAL AND PRACTICAL IMPLICATIONS

The present study has several theoretical and practical implications. At a theoretical level, this study advances knowledge on the Flipped Learning (FL) model, highlighting the crucial role of teacher feedback in its implementation. This work provides a solid foundation for future research aimed at optimizing FL effectiveness and suggests new lines of study related to the impact of these dynamics in different educational contexts and academic levels. At a practical level, this study underscores the need for educators to integrate continuous and meaningful feedback processes to maximize the benefits of FL. Feedback not only enhances intrinsic motivation but also helps mitigate amotivation and improves academic performance, making it an essential element in FL planning. Finally, this study offers a practical guide for educational institutions and teachers seeking to innovate their teaching methods, demonstrating how a well-implemented approach can contribute to more effective and engaging learning experiences.

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ANEXX 1

Questions Presented in Each of the Videos

Factor	Items
Conceptual Approach	a. What do you understand by a teaching style? b. One of the objectives of Muska Mosston's classification of teaching styles was to analyze them based on the level of student independence in learning. (T or F) c. Why use teaching styles? d. Which teaching style is better?
Traditional Styles	a. Explain in your own words what a traditional teaching style is. b. List two advantages of direct instruction. c. List two disadvantages of task assignment. d. Which of the three teaching styles presented in the video allows the most student independence in learning?: i. Modified direct instruction; ii. Direct instruction; iii. Task assignment.
Participatory Styles (Reciprocal Teaching)	a. What is the main characteristic of participatory styles? b. Identify a key aspect to consider when presenting a task to students. c. Provide an example (other than the one shown in the video) of how you would apply this teaching style.
Participatory Styles (Small Groups)	a. How does it differ from reciprocal teaching? b. What is the main characteristic of small-group teaching?
Participatory Styles (Microteaching)	a. What is meant by "student participation"? b. Can you provide a practical example of this teaching style?
Individualized Styles	a. What are individualized teaching styles based on? b. List two advantages of group work. c. List two disadvantages of programmed instruction. d. Which of the four teaching styles presented in the video allows the most student independence in learning? i. Modular teaching; ii. Programmed instruction; iii. Individualized programs; iv. Group work.
Socializing Styles	a. Explain what an effective teaching style is. b. How do the teaching styles described in the video prioritize the role of students in the classroom?
Cognitive Styles: Guided Discovery	a. State and explain one advantage of cognitive styles. b. Develop an example of how the guided discovery teaching style is applied. c. The guided discovery teaching style is based on continuous problem-solving. (T or F)
Cognitive Styles: Problem Solving	a. Can you explain the concept of the cognitive teaching style known as problem-solving in Physical Education? b. In the problem-solving teaching style, questions are formulated exclusively by students. (T or F)

Factor	Items
Creative Styles	a. Can you create an application of the creative style in a Physical Education class?
Conclusions	a. What do traditional teaching styles imply? b. Which of the six principles do you think is the most important? Why? c. Describe, in your own words, one way of understanding teaching styles. d. Some teaching styles are more important than others depending on the content to be taught by the teacher, who ultimately selects the most appropriate one. (T or F)
Physical Capacities in Primary Education	a. A good physical condition developed through basic physical capacities leads to better health in students. (T or F) b. Why is the development of basic physical capacities a key topic in primary school student development? c. List two advantages of developing basic physical capacities in primary school students.
Flexibility	a. What is flexibility based on? b. Provide an example of a static stretch and a dynamic stretch. c. Muscle elasticity must be specifically trained during primary education. (T or F)
Strength	a. Plyometric training with heavy weights is recommended in primary education. (T or F) b. Explain a game or activity that develops upper body strength.
Endurance	a. Aerobic endurance training in primary education is very important. Justify this statement. b. Describe a physiological adaptation derived from aerobic endurance training. c. Lactic anaerobic endurance training is highly important in primary education due to its beneficial effects on the respiratory and endocrine systems. (T or F)
Speed	a. What determines the success of a sports movement to increase the probability of success? b. Describe a game that develops reaction speed. c. Speed is the only basic physical capacity that declines from birth to old age. (T or F)

Note. T or F = True or False.